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SELF-RATINGS OF EIGHT FACTORS OF QUALITY MANAGEMENT AT NAVAL AVIONICS CENTER

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December, 1991

Prepared for: Naval Avionics Center, Indianapolis, Indiana.

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The focus of this report is the implementation of Total Quality Management in ten DoD organizations. The Participating organizations were all identified by the Federal Quality Institute as either winners or finalists for the Productivity/Quality Management and Budget. Qualitative data collected included interviews with either top executives or TQM coordinators, documentation of quality management activities. A questionnaire survey was also administered to the executive steering committee of each organization providing a self-assessment of eight dimensions of quality management practices. The report describes the lessons learned, promising practices and the results of the self-assessment survey for the participating organizations.

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SELF-RATINGS OF EIGHT FACTORS OF QUALITY MANAGEMENT AT NAVAL AVIONICS CENTER

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Abstract

The focus of this report is the implementation of Total Quality Management in ten DoD organizations. The participating organizations were all identified by the Federal Quality Institute as either winners or finalists for the Productivity/Quality Improvement Prototype (QIP) award sponsored by DoD and the Office of Management and Budget. Qualitative data collected included interviews with either top executives or TQM coordinators, documentation of quality management activities. A questionnaire survey was also administered to the executive steering committee of each organization providing a self-assessment of eight dimensions of quality management practices. The report describes the lessons learned, promising practices and the results of the self-assessment survey for the participating organizations.

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OVERVIEW

This report is derived from Master's thesis research conducted by Lt. Carolyn Applegate at the Naval Postgraduate School (Applegate, 1991). The focus of that thesis was to document the practices and experiences of ten exemplary DoD organizations in the implementation of Total Quality Management. Three types of data were collected from each organization. An interview was conducted with either the top executive (military or civilian) or TQM coordinator; documents describing TQM planning, achievements, activities were collected; and a questionnaire survey was distributed to the executive steering committee at each location to evaluate self-assessments of specific quality management practices. The thesis and a subsequent technical report (Applegate, Hocevar & Thomas, 1991) describe the results of both qualitative and quantitative data analyses presenting both lessons learned and promising practices for the entire sample of organizations.

The focus of this companion report is on the results of the quantitative survey data gathered from one of the participating organizations -- the Naval Avionics Center (NAC). As described in the larger study, self-assessment of management practices can be a valuable tool in the achievement of quality improvements. The intent of this report is to provide NAC with data representing the top management group's self-assessment of the organization's quality management practices for their use in planning their continuous improvement strategies.

BACKGROUND

For the past few years, top executives in a number of industries have been rethinking how to measure quality performance. During the 1980s, many managers involved in the quality movement came to realize that quality is a strategic weapon in a competitive world; this resulted in new performance measures such as tracking defect rates and response times (Troxell, 1981). The impetus of growth of the Total Quality concept, development of the Malcolm Baldridge National Quality Award, and increasingly stringent manufacturer demands on quality of supplier goods have led to a broadening of performance measures through an emphasis on quality. (Eccles, 1991)

One problem with these new performance measurements is that relying on measurements of customer satisfaction, quality, and innovation is not as well ingrained in today's managers as financial performance measures. Current information resources do not readily support real-time management using new quality measures because they were designed based on traditional accounting systems. Real-time, operational measures of quality management, which broaden the basis of organizational performance measurement, can aid decision-makers to influence critical areas such as process management in order to improve performance. (Goldratt and Cox, 1986)

Most organizations which use statistical process control tools collect performance data such as rework or defect rates that focus on production. However, these measures are limited in that they do not reflect organization-wide quality management. Various authors on quality recommend principles for effectively managing quality. These include Deming (1982;1986), Juran's (1986) quality trilogy, Crosby's (1979) zero-defect improvement programs, Ishikawa's (1985) total quality control, and Leonard and Sasser's (1982) identification of

quality levers. It is notable that all of these authors discuss the ideals of top management commitment, education, continuous improvement, and employee involvement. Examination of these and other principles provides a foundation for recognizing areas critical to any change in quality focus.

The first thorough and systematic attempt to synthesize some of these quality concepts is shown in Table 1, adapted from a previous study (Saraph, Benson and Schroeder, 1989). Building on the writings of quality management authors, Saraph et al. propose organizational requirements for effective quality management. These organizational requirements are classified into eight critical factors necessary to achieve a successful shift to a quality focus. They include: the role of management, leadership and quality policy; the role of the quality department; training; product and service design; supplier quality management; process management; quality data and reporting; and employee relations. Measures of these critical factors can form a profile of an organization's quality management practices that provides a benchmark for making decisions to achieve higher or more ideal levels of quality within an organization. The eight critical factors and an explanation of what they represent are shown in Table 2.

METHODOLOGY

Choice of Organizations

The DOD/Office of Management and Budget's (OMB) Productivity/Quality Improvement Prototype (QIP) was selected as the criterion for research participation. The purpose of this award is to recognize early successes, provide models for productivity improvement in other agencies, and provide visibility for high achievers. The Federal Quality Institute was contacted in order to develop a list of QIP winners and finalists since the award's inception

Table 1: ORGANIZATIONAL REQUIREMENTS FOR EFFECTIVE QUALITY MANAGEMENT EMPHASIZED BY SELECTED AUTHORS (adapted from Saraph et al., 1989)

Critical Factors	(Crosby, 1979)	(Deming, 1982; 1986)	(Garvin, 1983)	(Juran, 1978; 1986; 1989)	(Ishikawa, 1985)	(Leonard and Sasser, 1982)
Role of top management leadership and quality policy	Management commitment, quality goal setting.	Define management's permanent commitment to implement Deming's principles. Create constancy of purpose towards quality. Adopt new management philosophy towards defects, mistakes, and defective materials.	Set quality programs and policies, attitudes of management and employees.	Upper management leadership and quality policy.		Personal concern for quality and quality-conscious management style. Assign responsibility for quality. Top management's strategic support for quality.
Role of the quality department	Quality councils. Quality improvement teams.			Organizational mechanism/ program to improve quality.	Quality function is the responsibility of all departments.	Professional quality assurance and control staff.
Training	Supervisor and employee training.	Use modern methods of training using statistics. Institute vigorous program of training and education.		Training, at all levels appropriate to quality tools.	Training of employees in problem solving, data analysis and statistical techniques.	Training and development of management and employees.
Product/service design	Full understanding of customer product and service requirements.		Product design through reliability planning, trial production, and testing and producibility.	Product design emphasizing fitness for use.		

Supplier quality management		Reduce suppliers, award contracts on basis of quality. Do not choose suppliers on cost alone.	Vendor management by streamlining vendors, long term relationships, emphasis on quality, not cost.	Vendor relations using statistical methods.		
Process management	Qualification of process. Corrective action. Zero defect planning. Error-cause removal.	Use statistical tools in manufacturing and purchasing. Search continually for problems in system (design, materials, machines, training, supervision). Emphasize teamwork for solving quality problems (sales, manufacturing, research and design).	Production and workforce policies, smooth production schedule.	Process design emphasizing quality planning and quality improvement.	Process improvement through problem analysis.	Organization-wide analysis of quality problems.
Quality data and reporting	Quality measurement. Cost of quality.	Use statistical methods to improve quality continuously.	Quality information system.	Quality Information system, including cost of quality, external and Internal failure data.	Quality data gathering and analysis at all levels.	Quality information system for effective decision making at management and employee levels.
Employee relations	Employee recognition. Quality awareness. Zero-defect day.	Remove all barriers to workers' pride of workmanship. Eliminate quality-related numerical goals and quotas. Modern supervision ensuring immediate action on quality problems. Encourage communication.	Employee Involvement In quality Improvement at all levels and In all functions.	Employee relations including quality circles.	Employee involvement in quality problem solving.	Open participation by employees in quality improvement.

Table 2: CRITICAL FACTORS OF QUALITY MANAGEMENT
(adapted from Saraph et al.,1989)

Critical Factors of Quality Management	Explanation of Critical Factors
1. Role of management leadership and quality policy	Acceptance of quality responsibility by top management and department heads. Evaluation of top management on quality. Participation by top management in quality improvement efforts. Specificity of quality goals. Importance attached to quality in relation to cost and schedule. Comprehensive quality planning.
2. Role of the quality department	Visibility and autonomy of the quality department. Quality department's access to top management. Use of quality staff for consultation. Coordination between quality department and other departments. Effectiveness of the quality department.
3. Training	Provision of statistical training, trade training, and quality-related training for all employees.
4. Product/service design	Thorough scrub-down process. Involvement of all affected departments in design reviews. Emphasis on producibility. Clarity of specifications. Emphasis on quality, not roll-out schedule. Avoidance of frequent redesigns.
5. Supplier quality management	Fewer dependable suppliers. Reliance on supplier process control. Strong interdependence of supplier and customer. Purchasing policy emphasizing quality rather than price. Supplier quality control. Supplier assistance in product development.
6. Process management	Clarity of process ownership, boundaries, and steps. Less reliance on inspection. Use of statistical process control. Selective automation. Fool-proof process design. Preventive maintenance. Employee self-inspection. Automated testing.
7. Quality data and reporting	Use of quality cost data. Feedback of quality data to employees and managers for problem solving. Timely quality measurement. Evaluation of managers and employees based on quality performance. Availability of quality data.
8. Employee relations	Implementation of employee involvement and quality circles. Open employee participation in quality decisions. Responsibility of employees for quality. Employee recognition for superior quality performance. Effectiveness of supervision in handling quality issues. On-going quality awareness of all employees.

in 1988. The resulting list identified 23 organizations, 11 of which were within DOD. All the DOD organizations were contacted and 10 agreed to participate. Each DOD organization provided a point of contact responsible for all administration concerned with this study. A list of the participating organizations is given in Appendix A.

Questionnaire Survey

A survey was adapted from a private sector study which developed and validated an instrument to measure the critical factors of quality management (Saraph, Benson and Schroeder, 1989). As described in the background section, the original survey developers based the questions on the current literature on quality management including such authors as Deming, Juran, Ishikawa, and Crosby. The questionnaire was validated using a sample from private sector organizations in Minneapolis, Minnesota including 3M, Control Data, and Northwest Airlines.

The adapted form of the survey contains 66 questions composing the eight critical factors that assess a manager's perception of actual quality practices within his/her organization. Question wording was minimally modified to fit DoD organizations (e.g., "top executive" was changed to "commanding officer or executive director"). The modified survey as it was administered for this study is shown in Appendix B. Additional information on the reliability and validity of the survey instrument can be found in Appendix C.

A typical survey item, as shown below, allows managers to indicate their perception of the degree or extent of a given practice within their organization:

	Extent or Degree of Current Practice Is				
	Very low	Low	Medium	High	Very High
amount of final inspection, review or checking	1	2	3	4	5

Survey respondents were instructed to circle the number that represented their perception of quality management practices in their organization. Each critical factor was assessed using several component questions. For each component question and for each critical factor, the actual level of practice within or across organizations is represented by the average of the respondents' ratings for the component question or critical factor. The scale scores were calculated by summing the component item ratings and dividing by the number of items. The items comprising each critical factor along with the coefficient alpha statistic of internal consistency reliability are presented in Table 3.

Survey Administration

The survey respondents chosen within the ten organizations were members of each organization's quality council or executive steering committee, because these people serve to lead the quality focus within each organization. Survey data was collected in May, 1991. Each survey respondent assessed the degree or extent of actual quality management practices in his/her organization according to the measure described above. Table 4 lists the ten organizations anonymously, along with the number of responses anticipated and the number of survey responses received. At NAC (organization #2 in Table 4), eleven members of the Continuous Improvement Council participated in the study.

Data Analysis

Data were analyzed both in terms of individual items and the composite scales representing each of the eight critical factors of

Table 3: INTERNAL CONSISTENCY RELIABILITY ANALYSIS RESULTS FOR THE CRITICAL FACTORS OF QUALITY MANAGEMENT

Critical Factors and component questions	Coefficient Alpha
Role of top management leadership and quality policy	
-extent to which the top executive assumes responsibility for quality performance	
-acceptance of responsibility for quality by major branch/department heads within the organization	
-degree to which top management (commanding officer/executive director/major department heads) is evaluated for quality performance	
-extent to which top management supports long-term quality improvement process	
-degree of participation by major branch/department heads in the quality improvement process	
-extent to which top management has objectives for quality performance	
-specificity of quality goals within the organization	
-comprehensiveness of the goal-setting process for quality within the organization	
-extent to which quality goals and policy are understood within the organization	
-importance attached to quality by top management in relation to cost and schedule objectives	
-amount of review of quality issues in top management meetings	
-degree to which top management considers quality management as a way to increase revenues/reduce costs	
-degree of comprehensiveness of the quality plan within the organization	.91
Role of the quality department	
-visibility of the quality department	
-quality department's access to top management	
-autonomy of the quality department	
-amount of coordination between the quality department and other departments	
-effectiveness of the quality department in improving quality	.74
Training	
-specific work-skills training (technical and vocational) given to non-supervisory employees throughout the organization	
-quality-related training given to non-supervisory employees throughout the organization	
-quality-related training given to managers and supervisors throughout the organization	
-training in the "total quality concept" (i.e. philosophy of organization-wide responsibility for quality) throughout the organization	
-training in the basic statistical techniques (such as histograms and control charts) in the organization as a whole	
-training in advanced statistical techniques (such as design of experiments and regression analysis) in the organization as a whole	
-commitment of the top management to employee training	
-availability of resources for employee training	.82
Product/service design	
-thoroughness of new process/service design reviews before the process/service is implemented/produced	
-coordination among affected departments in the process/service development process	
-quality of new processes/services emphasized in relation to cost or schedule objectives	
-clarity of process/service specifications and procedures	
-extent to which implementation/producibility is considered in the process/service design process	
-quality emphasis by customer service employees	.82

Supplier quality management	
-extent to which suppliers are selected based on quality rather than price or schedule	
-thoroughness of the supplier rating system	
-reliance on reasonably few dependable suppliers	
-amount of education of suppliers by the organization	
-technical assistance provided to suppliers	
-involvement of the supplier in the product development process	
-extent to which longer term relationships are offered to suppliers	
-clarity of specifications provided to suppliers	.85
Process management	
-use of acceptance sampling to accept/reject lots or batches of work	
-amount of preventive equipment maintenance	
-extent to which inspection, review or checking of work is automated	
-amount of incoming inspection, review or checking	
-amount of in-process inspection, review or checking	
-amount of final inspection, review or checking	
-stability of production schedule/work distribution	
-degree of automation of the process	
-extent to which the design is "fool-proof" and minimizes chances of employee errors	
-clarity of work or process instructions given to employees	.73
Quality data and reporting	
-availability of cost of quality data in the organization	
-availability of quality data (error rates, defect rates, scrap, defects)	
-timeliness of the quality data	
-extent to which quality data (cost of quality, defects, errors, scrap, etc.) are used as tools to manage quality	
-extent to which quality data are available to non-supervisory employees	
-extent to which quality data are available to managers and supervisors	
-extent to which quality data are used to evaluate supervisor and managerial performance	
-extent to which quality data, control charts, etc., are displayed at employees' workstations	.88
Employee relations	
-extent to which quality circle or employee involvement type programs are implemented in the organization	
-effectiveness of the quality circle or employee involvement type programs in the organization	
-extent to which employees are held responsible for error-free output	
-amount of feedback provided to employees on their quality performance	
-degree of participation in quality decisions by non-supervisory employees	
-extent to which quality awareness building among employees is ongoing	
-extent to which employees are recognized for superior quality performance	
-effectiveness of supervisors in solving problems/issues	.80

Table 4: SURVEY RESPONSE

Organization	Surveys received	Surveys sent	Response rate
#1	7	7	100%
#2	11	13	85%
#3	14	25	56%
#4	10	15	67%
#5	10	12	83%
#6	11	15	73%
#7	20	27	74%
#8	8	8	100%
#9	6	12	50%
#10	5	8	63%
Total	102	142	72%

quality management. Scale scores were calculated by summing the items comprising each scale and dividing by the number of items. This allows the scale scores to retain the same units of measure for ease of comparability.

Two sets of analyses were performed on these data. The first analysis addressed NAC data solely and provides for all questions in the survey both the mean rating and the frequency of responses in each rating category. The mean rating represents the overall attitude of the group on the degree of practice for each particular aspect of quality management. The frequency demonstrates the degree of agreement that exists within the group on the status of managerial practice for each item.

The second analysis compared the self-ratings of NAC with those from the remaining DoD organizations for all of the individual items comprising

the eight critical factors of quality management. This comparison uses a t-test comparison of means and a critical t-value appropriate for a significance level of .10. When the variances of the two groups (NAC and other DoD) were not statistically different, the pooled variance estimate for the t-value and significance level was used. If the variances were statistically different, the separate variance estimate was used.

RESULTS EXAMINING NAC DATA ONLY

Tables 5-12 present the mean or average rating of NAC participants for each item in the eight critical factors of quality management. Also shown are the frequency of responses for each rating category. The items are organized according to the 8 factors. The presentation of items is from highest to lowest rated within each factor category. In interpreting these means, note that a value of "3" represents a moderate rating of the extent of current practice. It is important to note that the ratings reflect the executive steering committee's self-evaluation of current TQM practices. In other words, the data reflect how the top management at NAC think they are doing on specific TQM-related activities. There are no norms for evaluating "good" or "poor" performance. The value of these data is in guiding discussion and critical analysis of the implications for action planning.

Factor #1: Role of Top Management Leadership and Quality Policy

The means and frequency of responses for factor #1 are presented in Table 5. Within this factor, "Role of top management leadership and quality policy," the most highly rated items are "the extent to which top management supports long-term quality improvement process," "the degree of participating by major branch or department heads

Table 5
Factor #1: Role of Top Management Leadership and Quality Policy
Frequencies and Means of NAC Self-Ratings

Rating 5 4 3 2 1	Mean	Item
5 6 0 0 0	4.5	extent to which top management supports long-term quality improvement process
2 7 2 0 0	4.0	degree of participation by major branch or department heads in the quality improvement process
5 3 2 0 1	4.0	degree to which top management considers quality management as a way to increase revenues/reduce costs
3 5 1 2 0	3.8	extent to which the top executive assumes responsibility for quality performance
3 5 1 1 1	3.7	importance attached to quality by top management in relation to cost and schedule objectives
1 4 5 1 0	3.5	acceptance of responsibility for quality by major branch/department heads within the organization
0 7 2 1 1	3.4	extent to which top management has objectives for quality performance
2 3 3 2 1	3.3	amount of review of quality issues in top management meetings
1 1 7 1 1	3.0	degree of comprehensiveness of the quality plan within the organization
0 5 2 3 1	3.0	degree to which top management (commanding officer/executive director/major department heads) is evaluated for quality performance
0 4 3 3 1	2.9	specificity of quality goals within the organization
0 1 7 3 0	2.8	extent to which quality goals and policy are understood within the organization
0 1 7 3 0	2.8	comprehensiveness of the goal-setting process for quality within the organization
	3.4	**Overall Score for Critical Factor # 1**

in the quality improvement process," and "the degree to which top management considers quality management as a way to increase revenues/reduce costs." Each of these three items has a mean rating of greater than 4.0. The aspects of factor #1 that receive the lowest self-rating all relate to quality goals. The specificity of quality goals, the extent to which these goals are understood within the organization, and the comprehensiveness of the goal-setting process for quality all receive ratings below 3.0.

Factor #2: Role of the Quality Department

All five items comprising this section (see Table 6) have mean ratings of at least 3.5, indicating a positive view of the managerial practices related to the quality department. The highest rating is for the quality department's access to top management. The lowest ratings in this section are for the autonomy of the department ($\bar{x}$=3.6) and the effectiveness of the department in improving quality ($\bar{x}$=3.5).

Factor #3: Training

Two items in the training factor are rated the highest in this category (see Table 7) with means greater than 4.0. These are "commitment of top management to employee training" and "training in the total quality concept...throughout the organization." The two items with the lowest self-ratings pertain to quality-related training given to non-supervisory employees, and training in advanced statistical techniques with means of 3.2 and 2.7, respectively.

Factor #4: Product/Service Design

The range of means within this factor of quality management is fairly narrow (see Table 8). The highest self-rating is for coordination

Table 6
Factor #2: Role of Quality Department
Frequencies and Means of NAC Self-Ratings

Rating 5 4 3 2 1	Mean	Item
8 3 0 0 0	4.7	quality department's access to top management
3 5 3 0 0	4.0	visibility of the quality department
2 5 4 0 0	3.8	amount of coordination between the quality department and other departments
2 6 1 1 1	3.6	autonomy of the quality department
0 6 4 1 0	3.5	effectiveness of the quality department in improving quality
	3.9	**Overall Score for Critical Factor # 2**

Table 7
Factor #3: Training
Frequencies and Means of NAC Self-Ratings

Rating 5 4 3 2 1	Mean	Item
4 7 0 0 0	4.4	commitment of the top management to employee training
4 6 1 0 0	4.3	training in the "total quality concept" (i.e. philosophy of organization-wide responsibility for quality) throughout the organization
3 4 3 1 0	3.8	availability of resources for employee training
3 3 4 1 0	3.7	quality-related training given to managers and supervisors throughout the organization
2 4 5 0 0	3.7	training in the basic statistical techniques (such as histograms and control charts) in the organization as a whole
1 4 6 0 0	3.5	specific work-skills training (technical and vocational) given to non-supervisory employees throughout the organization
0 3 7 1 0	3.2	quality-related training given to non-supervisory employees throughout the organization
0 3 3 4 1	2.7	training in advanced statistical techniques (such as design of experiments and regression analysis) in the organization as a whole
	3.7	**Overall Score for Critical Factor # 3**

Table 8
Factor #4: Product/Service Design
Frequencies and Means of NAC Self-Ratings

Rating 5 4 3 2 1	Mean	Item
1 4 5 1 0	3.5	coordination among affected departments in the process/service development process
0 6 4 1 0	3.5	quality of new processes/services emphasized in relation to cost or schedule objectives
1 3 5 2 0	3.3	extent to which implementation/producibility is considered in the process/service design process
0 1 10 0 0	3.1	clarity of process/service specifications and procedures
0 2 7 2 0	3.0	thoroughness of new process/service design reviews before the process/service is implemented/produced
0 1 8 2 0	2.9	quality emphasis by customer service employees
	3.2	**Overall Score for Critical Factor # 4**

among departments in the development process ($\bar{x}$=3.5); while the lowest is for the quality emphasis by customer service employees ($\bar{x}$=2.9). As with the interpretation of all results, the implications of these ratings depends on the goals and capabilities of the organization. Within this factor, all ratings are clustered fairly closely to the midpoint of the rating scale, indicating that the executive group perceives a moderate degree of practice of these specific management activities in support of quality. Whether this represents a satisfactory achievement of quality practices in this area or becomes a benchmark for increased attention to these activities depends on the organizations's strategies for improving quality.

Factor #5: Supplier Quality Management

Of the eight items comprising this critical factor, only three show means greater than or equal to the midpoint of 3.0 (see Table 9). These include: "extent to which suppliers are selected based on quality rather than price or schedule" ($\bar{x}$=3.5), "thoroughness of the supplier rating system" ($\bar{x}$=3.2), and "clarity of specifications provided to suppliers" ($\bar{x}$=3.0). The item with the lowest mean rating of 1.8 pertains to the involvement of the supplier in the product development process.

Factor #6: Process Management

The items that receive the highest rating in this factor category (see Table 10) all relate to aspects of inspection (incoming, acceptance sampling, final, and in-process). The means for these four items range from 3.4 to 3.7 and indicate that the practice of inspections is perceived to be above the "moderate" level by the executive group at NAC. The issue of the role of inspections within the philosophy of TQM,

Table 9
Factor #5: Supplier Quality Management
Frequencies and Means of NAC Self-Ratings

Rating 5 4 3 2 1	Mean	Item
1 5 4 1 0	3.5	extent to which suppliers are selected based on quality rather than price or schedule
2 1 5 3 0	3.2	thoroughness of the supplier rating system
0 2 7 2 0	3.0	clarity of specifications provided to suppliers
0 2 6 3 0	2.9	technical assistance provided to suppliers
0 2 3 4 1	2.6	amount of education of suppliers by the organization
0 2 4 3 2	2.5	reliance on reasonably few dependable suppliers
0 2 3 5 1	2.5	extent to which longer term relationships are offered to suppliers
0 0 2 4 4	1.8	involvement of the supplier in the product development process
	2.7	**Overall Score for Critical Factor # 5**

Table 10
Factor #6: Process Management
Frequencies and Means of NAC Self-Ratings

Rating 5 4 3 2 1	Mean	Item
1 5 4 0 0	3.7	use of acceptance sampling to accept/reject lots or batches of work
2 5 3 0 1	3.6	amount of incoming inspection, review or checking
1 6 3 0 1	3.5	amount of final inspection, review or checking
0 5 5 1 0	3.4	amount of in-process inspection, review or checking
0 4 5 2 0	3.2	amount of preventive equipment maintenance
0 2 7 1 1	2.9	degree of automation of the process
0 2 5 4 0	2.8	stability of production schedule/work distribution
0 0 8 3 0	2.7	clarity of work or process instructions given to employees
0 1 7 2 1	2.7	extent to which inspection, review or checking of work is automated
0 0 4 7 0	2.4	extent to which the design is "fool-proof" and minimizes chances of employee errors
	3.1	**Overall Score for Critical Factor # 6**

particularly as applied by DoD organizations is hotly debated. Therefore, it is difficult to interpret these numbers. If NAC has determined a certain level of inspection is critical to operations, the ratings on these items may reflect the achievement of organizational objectives in this area. If, however, the organization is attempting to decrease its reliance on inspections, the ratings may reflect an area needing increased attention.

Three of the items in this factor category that have ratings below 3.0 relate to process activities that can diminish the reliance on inspections for quality. These include the stability of production schedule and work distribution ($\bar{x}$=2.8), the clarity of work or process instructions given to employees ($\bar{x}$=2.7), and the extent to which the design is "fool-proof" and minimizes chances of employee errors ($\bar{x}$=2.4).

Factor #7: Quality Data and Reporting

The ratings within this factor category (see Table 11) support the findings of the larger study from which these data are drawn (Applegate, 1991; Applegate, Hocevar & Thomas, 1991). That study reports the area of quality data is one of the most challenging being faced by all of the exemplary DoD organizations who participated. The self-rating data for NAC show that only two of the eight items have means above the midpoint -- availability of quality data and timeliness of quality data (3.2 and 3.0, respectively). The remaining items have means ranging from 2.5 to 2.9. These ratings demonstrate that the extent to which quality data is used for quality management, is available to or displayed for non-supervisory employees, or is used to evaluate managerial performance are

Table 11
Factor #7: Quality Data and Reporting
Frequencies and Means of NAC Self-Ratings

Rating 5 4 3 2 1	Mean	Item
1 2 6 2 0	3.2	availability of quality data (error rates, defect rates, scrap, defects)
0 3 5 3 0	3.0	timeliness of the quality data
0 2 7 1 1	2.9	extent to which quality data are available to managers and supervisors
0 3 3 5 0	2.8	extent to which quality data (cost of quality, defects, errors, scrap, etc.) are used as tools to manage quality
0 1 5 5 0	2.6	extent to which quality data are available to non-supervisory employees
0 2 5 2 2	2.6	extent to which quality data, control charts, etc., are displayed at employees' workstations
0 2 4 3 2	2.5	extent to which quality data are used to evaluate supervisor and managerial performance
0 1 4 5 1	2.5	availability of cost of quality data in the organization
	2.8	**Overall Score for Critical Factor # 7**

practices that NAC may want to discuss as possible actions for improving the effective use of quality data.

Factor #8: Employee Relations

The final quality management category shows a range of self-ratings from 2.5 to 3.5 (see Table 12). The extent to which quality awareness building is ongoing among employees and the extent to which employee involvement type programs are implemented both have mean ratings of 3.5. The lowest mean rating (2.5) is for the extent to which employees are held responsible for error-free output. The amount of feedback provided employees on their quality performance and the degree of participation in quality decisions by non-supervisory employees both receive mean ratings of 2.7. The value of these results is that they focus on specific aspects of employee involvement in the quality improvement process. Thus, these practices can be discussed explicitly by the executive group as to their potential value and the best mechanisms for implementing them if such a decision should be made.

RESULTS COMPARING NAC WITH OTHER DOD EXEMPLARY ORGANIZATIONS

The preparation and presentation of results comparing NAC's self-evaluation with the self-evaluation of the other exemplary DoD organizations was done at the request of NAC's executive steering group. There are several cautions that should be mentioned before describing these results. First, these data do not represent objective performance ratings, but the self-evaluation of organizational members. For this reason, the interpretation of comparative results is difficult. It is possible, for example, that within the DoD sample there may be inflated self-perceptions as a result of having recently won the quality award --

Table 12
Factor #8: Employee Relations
Frequencies and Means of NAC Self-Ratings

Rating 5 4 3 2 1	Mean	Item
0 6 4 1 0	3.5	extent to which quality awareness building among employees is ongoing
1 4 5 1 0	3.5	extent to which quality circle or employee involvement type programs are implemented in the organization
1 2 5 2 1	3.0	extent to which employees are recognized for superior quality performance
0 2 8 0 1	3.0	effectiveness of supervisors in solving problems/issues
0 3 5 3 0	3.0	effectiveness of the quality circle or employee involvement type programs in the organization
0 1 7 2 1	2.7	amount of feedback provided to employees on their quality performance
0 0 8 3 0	2.7	degree of participation in quality decisions by non-supervisory employees
0 0 7 2 2	2.5	extent to which employees are held responsible for error-free output
	3.0	**Overall Score for Critical Factor # 8**

"We just 'won'! We must be doing great!" This phenomenon is referred to as retrospective rationality (Pfeffer, 1982) and can lead to exaggerated differences between the self-ratings of the larger group that includes some award winners, and the self-ratings of NAC that may be casting a critical eye on its own performance in trying to enhance quality operations. However, the influence of retrospective rationality is only speculative; there is no way to evaluate the "accuracy" of the self-report data within the design constraints of this study.

A second caution follows the warning of TQM advocates against seeking a "recipe for success" by following the model of another organization. To the extent that the achievement of other organizations can inspire NAC to further pursue aspects of quality management, these comparative results may prove to be motivational. There are potential benefits to the competition inherent in comparison data; but competition can also be dysfunctional if the pursuit of a certain activity is undertaken because others are rating themselves higher in that area rather than because it is determined to be the appropriate activity given the organization's own analyses of quality processes.

In addition to the increased motivation mentioned above, another potential value of the comparative data is in highlighting areas where other organizations may have developed innovative practices. Such innovative practices are briefly described and contact points are identified in the full reports of this research project (see Applegate, 1991; or Applegate, Hocevar & Thomas, 1991). A final value of the comparative results is in identifying areas where the challenge of implementing quality management is experienced by other exemplary

organizations. In other words, practices where NAC's self-rating is low may also be reported as low by other organizations, indicating the difficulty inherent in the changes required by continuous improvement. This occurs in a number of items where there is no significant difference between NAC's self-rating and the self-ratings of the other DoD organizations on items identified as problematic in the review of previously described results.

Overview of Comparative Findings

The t-test comparison of means for all 66 items was conducted with NAC (N=11) and the remaining DoD organizational participants (N=91) as the two comparison groups. The two groups were found to have self-ratings that were <u>not</u> significantly different for more than 70% of the items. This indicates that in most of the areas of quality management practices, NAC's self-rating of the extent of current practice is the same as the self-rating of other exemplary DoD organizations.

Practices Where NAC Ratings Were Higher Than DoD Ratings

The practices where NAC's self-ratings were significantly higher than the DoD comparison group are presented in Table 13; the items are all from two categories of quality management -- supplier quality management and process management. In the first category, the extent to which suppliers are selected on the basis of quality rather than price or schedule and the thoroughness of the supplier rating system show NAC with mean ratings greater than the DoD comparison group. This result is not surprising given the Blue Ribbon Contractor program that has been developed at NAC and is documented in the larger report as an exemplary practice (see Applegate, 1991; Applegate, Hocevar & Thomas, 1991).

Table 13

Quality Management Items Showing

NAC Self-Ratings as Higher[1] than

Other DoD Benchmark Organizations

Mean Ratings NAC (N=11)	DoD (N=91)	Item
5. Supplier quality management		
3.5	2.2	extent to which suppliers are selected based on quality rather than price or schedule
3.2	2.4	thoroughness of the supplier rating system
6. Process management		
3.7	2.7	use of acceptance sampling to accept/reject lots or batches of work
3.6	2.8	amount of incoming inspection, review or checking
3.5	3.0	amount of final inspection, review or checking
2.7	2.3	extent to which inspection, review or checking of work is automated

[1] Differences were determined using a t-test comparison of mean ratings. All those reported are significant $p<.10$. All items not reported showed no difference between NAC and the other participating organizations.

The second category of process management has four items where NAC's mean ratings were significantly greater than the comparison group. These items all relate to inspections. As discussed in the description of results that examined solely NAC data, the interpretation of these findings is problematic. If the goal of the organization is to decrease reliance on inspections, this difference may indicate that NAC, while scoring higher, is not as far along as the other organizations perceive themselves to be in achieving this quality aim. However, it is also possible that NAC has determined that inspections cannot be decreased due to the nature of the process or product. The interpretation and determination of subsequent actions based on these results is fundamentally the responsibility of organizational members.

Practices Where NAC Ratings Were Lower Than DoD Ratings

The items showing NAC with mean self-ratings lower than the DoD comparison group are presented in Table 14. Several of the items included in these results have already been identified as potentially problematic in the discussion of results for the NAC data alone. For example, within the first category, the two items on the comprehensiveness of the goal setting process for quality and the extent of understanding within the organization of quality goals and policies were found to have the lowest mean self-ratings based on the examination of NAC data. Two additional items where other DoD organizations report higher means also relate to this theme: "degree of comprehensiveness of the quality plan within the organization," and "extent to which top management has objectives for quality performance." The final item in this category

Table 14

Quality Management Items Showing

NAC Self-Ratings as Lower[2] than

Other DoD Benchmark Organizations

NAC (N=11)	DoD (N=91)	
1. Role of top management leadership and quality policy		
2.8	3.3	comprehensiveness of the goal-setting process for quality within the organization
2.8	3.3	extent to which quality goals and policy are understood within the organization
3.0	3.5	degree of comprehensiveness of the quality plan within the organization
3.0	3.5	degree to which top management (commanding officer, executive director, major department heads) is evaluated for quality performance
3.4	3.9	extent to which top management has objectives for quality performance
3. Training		
3.2	3.8	quality-related training given to non-supervisory employees throughout the organization
4. Product/service design		
2.9	3.6	quality emphasis by customer service employees

[2] Differences were determined using a t-test comparison of mean ratings. All those reported are significant $p<.10$. All items not reported showed no difference between NAC and the other participating organizations.

Table 14 (cont'd)

NAC (N=11)	DoD (N=91)	
5. Supplier quality management		
1.8	2.3	involvement of the supplier in the product development process
6. Process management		
2.7	3.2	clarity of work or process instructions given to employees
7. Quality data and reporting		
2.9	3.4	extent to which quality data are available to managers and supervisors
8. Employee relations		
3.0	3.6	effectiveness of the quality circle or employee involvement type programs in the organization
3.0	3.5	effectiveness of supervisors in solving problems/issues
3.0	3.5	extent to which employees are recognized for superior quality performance
3.5	4.0	extent to which quality circle or employee involvement type programs are implemented in the organization
2.7	3.0	degree of participation in quality decisions by non-supervisory employees

shows that the other DoD organizations report a greater use of quality performance criteria in the evaluation of top management.

The next five categories of quality management each include only one item where NAC's self-rating was lower than the comparison group. In all cases, the items were identified as among the lowest self-rated in the previous discussion of NAC results. The items include: the extent of quality-related training given to non-supervisory employees, the quality emphasis by customer service employees, the involvement of the supplier in the product development process, and the clarity of work or process instructions given to employees. Again, these results suggest that the comparison data is redundant to the discussion of NAC data alone.

The final category of quality management is employee relations. In this category there were four items that had lower ratings than the comparison group. Only one of these items was identified in the previous discussion of results -- "degree of participation in quality decisions by non-supervisory employees. Two of the remaining items deal with the extent and effectiveness of quality circle or employee involvement programs; the last item relates to the effectiveness of supervisors in solving problems/issues.

DISCUSSION: HOW CAN THESE DATA BE USED?

As described in the introduction to the presentation of results, there are no norms against which the data in this study can be compared. The primary value of the data is in the fact that they represent a self-assessment of the quality management practices at NAC as perceived by the top management group. The Applegate study (1991) found that nonfinancial quality measures of real-time management are a rare commodity. The data

reported here can serve two primary purposes. First, they can be used to guide discussion among the executive steering group regarding actions that might be planned to further enhance quality at NAC. In this way, the data can be viewed as input to the "check" phase of the PDCA cycle. The executive steering group has planned and implemented numerous continuous improvement initiatives within the organization and these data can be used as a form of assessment of progress based on the perceptions of the organizational leaders. The variance in perceptions may illuminate activities within one part of the organization that are not well known by other parts of the organization; or may identify further opportunities for improvement by virtue of an innovative idea of one of the steering group members.

The second way in which these data may be used is as a baseline. As the organization continues its quality improvement activities, changes will occur. By using this survey with the same sample (or an expanded sample including Division managers or a other organizational members) over time, these changes can be tracked and the PDCA cycle continuously evaluated. This study is not intended to replace the need for more objective indicators of quality improvements; however, there is an important potential for insight into opportunities and barriers through the discussion of these data by the organizational decision makers.

APPENDIX A

RESEARCH PARTICIPANTS

The executive steering group or committee at each of the following organizations participated in the thesis survey. A point of contact (POC) is shown for each organization as well as the name and title for each organization's interviewee.

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APPENDIX B: SURVEY QUESTIONS

	Extent or Degree of Current Practice Is				
	Very Low	Low	Medium	High	Very High
Extent to which the top executive assumes responsibility for quality performance	1	2	3	4	5
Visibility of the quality department	1	2	3	4	5
Specific work-skills training (technical and vocational) given to non-supervisory employees throughout the organization	1	2	3	4	5
Thoroughness of new process/ service design reviews before the process/service is implemented/produced	1	2	3	4	5
Extent to which suppliers are selected based on quality rather than price or schedule	1	2	3	4	5
Use of acceptance sampling to accept/reject lots or batches of work	1	2	3	4	5
Availability of cost of quality data in the organization	1	2	3	4	5
Extent to which quality circle or employee involvement type programs are implemented in the organization	1	2	3	4	5
Acceptance of responsibility for quality by major branch/ department heads within the organization	1	2	3	4	5
Quality department's access to top management	1	2	3	4	5
Quality-related training given to non-supervisory employees throughout the organization	1	2	3	4	5

	Extent or Degree of Current Practice Is				
	Very Low	Low	Medium	High	Very High
Coordination among affected departments in the process/ service development process	1	2	3	4	5
Thoroughness of the supplier rating system	1	2	3	4	5
Amount of preventive equipment maintenance	1	2	3	4	5
Availability of quality data (error rates, defect rates, scrap, defects)	1	2	3	4	5
Effectiveness of the quality circle or employee involvement type programs in the organization	1	2	3	4	5
Degree to which top management (commanding officer/executive director/major department heads) is evaluated for quality performance	1	2	3	4	5
Autonomy of the quality department	1	2	3	4	5
Quality-related training given to managers and supervisors throughout the organization	1	2	3	4	5
Quality of new processes/ services emphasized in relation to cost or schedule objectives	1	2	3	4	5
Reliance on reasonably few dependable suppliers	1	2	3	4	5
Extent to which inspection, review, or checking of work is automated	1	2	3	4	5
Timeliness of the quality data	1	2	3	4	5
Extent to which employees are held responsible for error-free output	1	2	3	4	5

	Extent or Degree of Current Practice Is				
	Very Low	Low	Medium	High	Very High
Extent to which top management supports long-term quality improvement process	1	2	3	4	5
Amount of coordination between the quality department and other departments	1	2	3	4	5
Training in the "total quality concept"(i.e. philosophy of organization-wide responsibility for quality) throughout the organization	1	2	3	4	5
Clarity of process/service specifications and procedures	1	2	3	4	5
Amount of education of suppliers by the organization	1	2	3	4	5
Amount of incoming inspection, review, or checking	1	2	3	4	5
Extent to which quality data (cost of quality, defects, errors, scrap, etc.) are used as tools to manage quality	1	2	3	4	5
Amount of feedback provided to employees on their quality performance	1	2	3	4	5
Degree of participation by major branch/department heads in the quality improvement process	1	2	3	4	5
Effectiveness of the quality department in improving quality	1	2		4	5
Training in the basic statistical techniques (such as histograms and control charts) in the organization as a whole	1	2	3	4	5
Extent to which implementation /producibility is considered in the process/service design process	1	2	3	4	5

	Extent or Degree of Current Practice Is				
	Very Low	Low	Medium	High	Very High
Technical assistance provided to suppliers	1	2	3	4	5
Amount of in-process inspection, review, or checking	1	2	3	4	5
Extent to which quality data are available to non-supervisory employees	1	2	3	4	5
Degree of participation in quality decisions by non-supervisory employees	1	2	3	4	5
Extent to which top management has objectives for quality performance	1	2	3	4	5
Training in advanced statistical techniques (such as design of experiments and regression analysis) in the organization as a whole	1	2	3	4	5
Quality emphasis by customer service employees	1	2	3	4	5
Involvement of the supplier in the product development process	1	2	3	4	5
Amount of final inspection, review, or checking	1	2	3	4	5
Extent to which quality data are available to managers and supervisors	1	2	3	4	5
Extent to which quality awareness building among employees is ongoing	1	2	3	4	5

	Extent or Degree of Current Practice Is				
	Very Low	Low	Medium	High	Very High
Specificity of quality goals within the organization	1	2	3	4	5
Commitment of the top management to employee training	1	2	3	4	5
Extent to which longer term relationships are offered to suppliers	1	2	3	4	5
Stability of production schedule/work distribution	1	2	3	4	5
Extent to which quality data are used to evaluate supervisor and managerial performance	1	2	3	4	5
Extent to which employees are recognized for superior quality performance	1	2	3	4	5
Comprehensiveness of the goal-setting process for quality within the organization	1	2	3	4	5
Availability of resources for employee training in the organization	1	2	3	4	5
Clarity of specifications provided to suppliers	1	2	3	4	5
Degree of automation of the process	1	2	3	4	5
Extent to which quality data, control charts, etc., are displayed at employee's work stations	1	2	3	4	5

	Extent or Degree of Current Practice Is				
	Very Low	Low	Medium	High	Very High
Effectiveness of supervisors in solving problems/issues	1	2	3	4	5
Extent to which quality goals and policy are understood within the organization	1	2	3	4	5
Extent to which process design is "fool-proof" and minimizes chances of employee errors	1	2	3	4	5
Importance attached to quality by top management in relation to cost and schedule objectives	1	2	3	4	5
Clarity of work or process instructions given to employees	1	2	3	4	5
Amount of review of quality issues in top management meetings	1	2	3	4	5
Degree to which top management considers quality management as a way to increase revenues/reduce costs .	1	2	3	4	5
Degree of comprehensiveness of the quality plan within the organization	1	2	3	4	5

APPENDIX C: STATISTICAL ANALYSIS OF SURVEY RESULTS

The survey used in this study is adapted from an instrument developed and validated by Saraph, Benson and Schroeder (1989). The Saraph et al. citation provides substantial evidence for the validity of the eight critical factors of quality management by evaluating content validity, criterion-related validity and construct validity.

For this research, the survey was modified by dropping 12 questions that were determined to be unreliable in the original study. As stated in the body of this report, additional modifications to wording were made to fit DoD organizations. The modified survey, containing 66 questions, was formally reviewed by two civilian professors of management in order to ensure the language changes would ease comprehension of the survey questions by the targeted audience, without changing the substantive intent of the questions.

The reliability of the survey data collected for this study was evaluated using the internal consistency method. Cronbach's alpha, which is well suited to attitude instruments in which multiple questions are used to address a single dimension (i.e. training, process management), was chosen to assess internal consistency reliability (Jaeger, 1983). The SPSS/PC+ reliability program was used to conduct the analysis (Norusis, 1990). Missing data, which was minimal, was handled by substituting the median score for each survey question, so as not to exclude any survey responses from this study.

Results for the eight critical factors' reliability are detailed in Table 3 (see the Methodology section), which shows that the reliability coefficients or alpha scores ranged from .73 to .91, all of which are

considered adequate for reliability of research instruments. This analysis demonstrates that different questions intended to measure the same critical factor show convergence (Cronbach, 1951; Jaeger, 1983; Yin, 1984). These results further supported reliability evidence presented by the original developers of the instrument.

A correlation matrix for the critical factors of quality management was completed as an additional measure of discriminant validity, and is detailed in the following table. Because the factors all deal with quality management, significant correlations are to be expected. All but four intercorrelations show at least 50% unique variance, thus supporting discriminant validity. The highest intercorrelation was found between leadership and employee relations (r=.79). This suggests that these two dimensions have 62% variance in common, and 38% unique variance. While this is not a strong indication of discriminant validity, it was felt to be sufficient for purposes of this study.

TABLE C: SCALE TO SCALE CORRELATION MATRIX FOR THE CRITICAL FACTORS OF QUALITY MANAGEMENT

Critical Factor	Scale # 1	2	3	4	5	6	7	8
Role of management leadership and quality policy (scale #1)	1.0	.58	.66	.71	.31	.46	.72	.79
Role of the quality department (scale #2)		1.0	.49	.58	.32	.37	.48	.58
Training (scale #3)			1.0	.56	.42	.43	.66	.66
Product/service design (scale #4)				1.0	.40	.58	.71	.69
Supplier quality management (scale #5)					1.0	.59	.42	.37
Process management (scale #6)						1.0	.64	.46
Quality data and reporting (scale #7)							1.0	.74
Employee relations (scale #8)								1.0

REFERENCES

Applegate, Carolyn, Total Quality Management in the Department of Defense: Lessons Learned, Innovative Practices, and Quality Measurements. Master of Science Thesis, Department of Administrative Sciences, Naval Postgraduate School, Monterey, CA, September, 1991.

Applegate, Carolyn, Hocevar, Susan Page, and Thomas, Kenneth W., Total Quality Management in Ten Examplary Department of Defense Organizations: Lessons Learned, Innovative Practices, and Quality Measurements. Technical Report (NPS-AS-003), Department of Administrative Sciences, Naval Postgraduate School, Monterey, CA, November, 1991.

Cronbach, J. L., "Coefficient Alpha and the Internal Structure of Tests," Psychometrika, Vol. 16, No. 3, September 1951, pp. 297-334.

Crosby, P.B., Quality is Free, New American Library, 1979.

Deming, W.E., "Improvement of Quality and Productivity through Action by Management," National Productivity Review, Winter 1981-1982, pp. 12-22.

Deming, W.E., Out of the Crisis, Massachusetts Institute of Technology, Center for Advanced Engineering, 1986.

Eccles, Robert G., "The Performance Measurement Manifesto," Harvard Business Review, January-February 1991, pp. 131-139.

Garvin, David A., "Quality on the Line," Harvard Business Review, September-October 1983, pp. 64-75.

Goldratt, Eliyahu M. and Cox, Jeff, The Goal: A Process of Ongoing Improvement, revised edition, North Rivers Press, Inc., 1986.

Ishikawa, Kaoru, What is Total Quality Control? the Japanese Way, Prentice-Hall, Inc., 1985.

Jaeger, Richard M., Statistics: A Spectator Sport, Sage Publications, Inc., 1983, pp. 93-101.

Juran, J.M., "Japanese and Western Quality: A Contrast in Methods and Results," Management Review, Vol. 67, No. 11, November 1978, pp. 26-29.

Juran, J.M., "The Quality Trilogy," Quality Progress, Vol. 9, No. 8, 1986, pp. 19-24.

Juran, J.M., Juran on Leadership for Quality: An Executive Handbook, The Free Press, 1989.

Leonard, Frank S., and Sasser, W. Earl, "The Incline of Quality," Harvard Business Review, September-October 1982, pp. 163-171.

Norusis, Marija J., SPSS/PC+ Statistics for the IBM PC/XT/AT and PS/2, SPSS Inc., 1990.

Pfeffer, Jeffrey, Organizations and organization theory, Boston: Pitman, 1982.

Saraph, Jayant V., Benson, P. George, and Schroeder, Roger G., "An Instrument for Measuring the Critical Factors of Quality Management," Decision Sciences, Vol. 20, 1989, pp. 810-829.

Troxell, Joseph R., "Service Time Quality Standards," Quality Progress, Vol. XIV, No. 9, September 1981, pp. 27-33.

Yin, Robert K., Case Study Research: Design and Methodology, Sage Publications, Inc., 1984.

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